THE RELATIONSHIP BETWEEN ACTIVITY LEVEL AND THE MOVEMENT PATTERN OF SUPINE TO STANDING

by

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CHAPTER 1

INTRODUCTION

Many human motor skills involve the ability to move in an upright position. To assume an erect stance, four movement patterns called righting reactions are used. Righting involves rolling from supine to prone, moving into a sitting position, getting up on all fours, and finally coming to an erect stance from the supine position.

Until recently, researchers in motor development believed that all healthy individuals performed using the most mature level of righting behaviors by adulthood (Espenschade, 1940, 1960; Gesell, 1940; McGraw, 1945; Schaltenbrand, 1927). All able-bodied adults are able to perform the motor tasks necessary for bipedal locomotion. In other words, the righting actions of adults have been viewed as representing the most developmentally advanced level of movement for these particular tasks. Because righting behaviors are established during the first few years of life (Bayley, 1969; Heinemann, 1975; McGraw, 1945; Ridenour, 1978; Shirley, 1931), they are assumed to be performed by adults in an automatic way. Adults sit up, stand, and walk with little conscious effort needed for the accomplishment of these movement patterns. Furthermore,

mature motor skills are theorized to remain stable throughout adulthood and any disruption of mature motor behavior is presumably the result of some pathological condition or physiological decline from aging.

One part of the study of motor development encompasses motor behaviors which appear in an orderly sequence of well-defined stages, classically associated with age. The information pertaining to human developmental sequences present in the literature focuses primarily on infancy through adolescence (Bayley, 1935, 1969; Espenschade, 1960; Gesell, 1940, 1946; Heinemann, 1975; McGraw, 1945; Ridenour 1978; Shirley, 1931). McGraw (1945) described motor skill development in terms of neuromuscular maturation in infants. Her research indicated that healthy infants acquire specific motor capabilities related to their age. This motor skill acquisition follows a predictable sequence which applies universally to all "normal" infants and children. Although most behaviors observed in infancy and childhood are predictable and universal, Shirley (1931) noted that no developmental sequence held true for all infants; that is, some variability between individuals existed in observed movement patterns.

A lack of motor sequence research beyond the childhood years reinforces the need to examine age-

related changes in movement patterns during the entire human life span (Haywood, 1986; Payne & Isaacs, 1987). Research in adult development currently suggests many reasons for deviations from the most mature movement pattern (Baltes, Reese, & Lipsitt, 1980; Lemes & Shambes, 1978; Leuring, 1988; VanSant, 1988). Segment length, weight, size, plus other anthropometric measures offer possible explanations for adult movement variations away from the most mature forms. Body weight, strength, and flexibility are other variables affecting movement patterns. Some of the factors mentioned are related to a person's activity level and fitness status.

A component approach to the description of movement patterns has been applied to a variety of movement skills, including righting reactions (Francis, 1986; Halverson & Williams, 1985; Lewis, 1986; Richter, 1985; Roberton & Halverson, 1984; Roberton, 1977, 1978; Sarnaki, 1985; VanSant, 1988; Williams, 1980). A component action, or movement component, is a partial movement pattern observed in a specified body region (Roberton & Halverson, 1984). This component method consists of examining movement in separate body regions to obtain an accurate and detailed description of the whole-body movement. General descriptions of movement patterns within a region of the body are called

component categories. These categories describe actions from least to most advanced. Developmental step or level are synonyns for the term category. By combining the separate component actions, a body action profile results. The profile represents a complete and detailed description of how the body moves by summing the actions of each body region. The most frequently, or commonly occurring category is called the modal component category. Similarly, the most frequently occurring body action profile is called the modal profile.

The component approach to movement description accounts for the individual variation of movement commonly observed in motor skills. Thus, a qualitative description of movement may be identified. All body regions may not progress simultaneously through developmental sequences so that differences result in the actions used to perform a task. Some of these differences may be associated with lifestyle patterns, particularly that of regular exercise.

Involvement in regular vigorous exercise is often credited with delaying the effects of aging on the human body (Aisenbrey, 1987; Bortz, 1982; Leuhring, 1988; Shephard, 1987; Smith, 1982). Aisenbrey (1987) and Smith (1982) noted that osteoporosis, considered to be part of the "normal" aging process unless it occurs in

conjunction with frequent fractures, may actually be reversed by regular, moderate exercise regimes. Bortz (1982) and Shephard (1987) associated disuse with an acceleration of the aging process by comparing biological changes of the cardiovascular system, blood components, body composition, metabolic and regulatory functions, and nervous system between persons confined to bedrest (forced inactivity) as compared to an elderly sample. Leuhring (1988) found that active elderly subjects moved using more developmentally advanced movement patterns than their sedentary counterparts. Physiological decrements that typically occur with aging may be diminished by participation in an ongoing exercise routine.

The actual age at which physiological decline begins is not clear. Extrinsic factors beyond age, such as exercise and diet, influence physiological functions. The physiological decrements associated with aging occur gradually so that symptoms may surface sometime after the actual onset of deterioration. Thus the rate of physiological decline, which varies from person to person, make the identification of the onset of decline very difficult.

The role of activity in performance of normal adult movement patterns is central to this descriptive analysis. The possibility of whether an active

lifestyle can offset the rate of physiological decline for such tasks as automatic righting behaviors is investigated. In addition, middle adulthood is evaluated as compared to the geriatric population studied in previous investigations.

Statement of the problem

The purpose of this investigation is twofold: 1) to apply a component approach to the developmental sequences in the supine to standing movement pattern of young adults, and 2) to determine if level of physical activity is related to one's ability to rise from a supine position to erect stance.

Significance of the study

The actual age where declines in physical functioning begin is not clear. The gradual nature of behavioral changes in adulthood creates difficulty in identifying the actual onset of physiological decline and the relationship of activity to this decline. The contemporary view of motor development suggests that age-related motor behaviors occur in a contextually appropriate manner for individuals in a specific

environment. The external influence of activity level may vary the rate of this developmental process during the adult years.

The current investigation is an extension of the work of VanSant (1983,1988) who identified the age-related property of the movement pattern of supine to standing throughout the entire lifespan. VanSant noted diversity of motor actions used by adults performing the rising pattern. Leuhring (1988) added to VanSant's findings by evaluating the supine to standing movement pattern in a geriatric population. Leuhring discussed the role of physical activity in affecting the rising movement. This investigation concerns itself with general activity levels and the qualitative movements observed in adults during middle adulthood.

The question of whether a person's righting movements are at the most advanced level and whether the movements remain unchanged during later childhood and adulthood has not been adequately substantiated by research. Such a lack of attention to this question points to the need to establish a baseline for normal adult movement patterns (Vansant, 1988).

The paucity of research on issues concerning changing movement patterns during the aging process is only compounded by the rapid growth of that segment in society over 65 years of age. Extended lifespans are

predicted in the population at large and, therefore, the factors associated with adult motor development need clarification. Further, the actual age when physiological declines begin and how these declines relate to lifestyle patterns have not been defined. Information on what alters adult motor development may also help adults to maintain lifestyles compatible with independent mobility throughout the entire lifespan. Lifestyle patterns of activity reinforce the significance of preventative medicine techniques. If activity plays an important role in the maintenance of advanced movement patterns, individuals can take responsibility for their own health by incorporating adequate exercise in their daily routines.

Hypotheses

1) Righting behaviors demonstrated by 30-39 year old adults moving from a supine to standing position can be reliably categorized using the component approach to movement description.

2) Physically active adults will demonstrate more developmentally advanced movement patterns than less physically active adults.

Delimitations

1) Subjects are healthy adults with no known physical or medical conditions that may interfere with physical activities.

2) Subjects are in the age range of 30-39 years old.

Limitations

1) Subjects were categorized according to their responses on an activity index and subsequently were placed in groups according to their pattern of activity.

2) Subjects were divided according to their reported current involvement in physical activity as opposed to past history of activity participation.

3) Past history of minor or temporary physical injuries might have altered some subjects movements.

CHAPTER 2

Review of the Literature

INTRODUCTION

This chapter begins with an historical outline of neurodevelopmental research, followed by a discussion of individual differences in the rate of motor skill development. The component approach is outlined after which a brief account of righting actions is discussed. Physical activity level effects on movement patterns are presented.

Neurodevelopment

The development of motor skills in humans is documented extensively from birth through young adulthood (Bayley, 1969; Espenscade, 1960; Gesell, 1946; Heinemann, 1975; McGraw, 1945; Ridenour, 1978; Shirley, 1931). The maturation process, resulting from biological changes as well as from environmental influences, corresponds with increasing physical independence. Normal, healthy infants gradually master the motor skills required to move from a lying position, to a crawling position, and eventually to an upright position for walking (Heinemann, 1975; McGraw, 1945/1963; Shirley, 1931).

Some researchers (Flavell, 1971; Jackson, 1889;

McGraw, 1945; Piaget, 1972;) correlate acquisition of higher level cognitive and motor skills with development of the central nervous system. As changes occur in the organization of the nervous system, new and more sophisticated behaviors emerge (Flavell, 1971). Thus, cognitive and motor behavior changes follow a pattern consistent with a metamorphosis of the central nervous system.

Piaget (1972) documented a series of predictable changes in cognitive behaviors which he called stages. Stage theory is an extension of biological psychology which credits behavior changes to higher evolution of the nervous system (Jackson's hierarchical theory, 1889). Five basic criteria are necessary to establish that stages are present. An 1) orderly sequence of change in behavior across time must occur; the sequence of change is 2) temporally invariant and is 3) universal, holding true cross-culturally; 4) hierarchical integration of stages exists such that each stage is necessary for the construction of the following stage; and 5) progressive differentiation is present so that, as development occurs, humans can selectively isolate intricate movements (Flavell, 1971).

The concept of motor development as described by a series of orderly changes over time was extended by

McGraw (1945) who identified predictable sequences of neuromuscular changes in infants. The development of increasingly advanced movement in infants involves the progression and modification of primitive reflex patterns seen at birth. These reflexes evolve into "righting reactions" which function to enable humans to stand in an erect position for bipedal locomotion (Heinemann, 1975; McGraw, 1945). Furthermore, the righting reactions correct and help to maintain this erect posture once humans have begun to walk. Development of righting abilities represents the progression toward physical independence.

Major physical accomplishments in infants are termed motor milestones (Bayley, 1935; Gesell, 1940) and include such abilities as head control, rolling, sitting, postural control, crawling, and walking. Most infants demonstrate an orderly, predictable sequence of behavior changes which follow an invariant pattern. Infants progress in motor skills in a hierarchical fashion with initial skills being integrated and incorporated into more advanced motor capabilities. These more advanced actions allow for more sophisticated movements reflective of greater voluntary control. Thus, motor behavior changes parallel the criteria of stage theory. Consequently, these changes have been evaluated against the principles of cognitive stage

theory.

Individual Differences

Baltes, Reese and Lipsitt (1980) described a life-span approach to development which assumed that developmental changes might occur at any time from conception to death. Life-span development primarily focuses on the dynamic nature of behaviorial change at all ages. This conceptualization is opposed to the traditional concept of neurodevelopment as a progression to maturity sometime in adulthood, followed by regression. Behavior changes noted throughout the lifespan follow an age associated pattern. Maturity levels, while age related, are also specific to each individual. In other words, maturity does not refer to any one specific point in time. Rather, level of maturity appears to be related to many factors characteristic of the individual and the experiences of that individual. Examples of these individual factors are strength, weight, activity level, and segment measurements. The identification of changes in behavior as they occur throughout the entire life course remain a primary interest in understanding life-span development (Baltes, Reese, & Lipsitt, 1980).

Piaget (1972) noted diversification of individual

capabilities. He stated that certain behavior patterns have general properties that are shared universally, however, large differences between persons exists, based on individual aptitudes.

Differences occur in the rate of development (Roberton, 1978) and in the level of movement maturity obtained by an individual (Leme & Shambes, 1978; VanSant, 1988). For example, Leme and Shambes (1978) observed immature, or less advanced, throwing patterns in normal adult women. Their findings suggest biological maturity and chronological age do not automatically ensure the attainment of the most advanced level of motor development. Factors such as motivation, socialization, cultural background, practice, and experience contribute to performance of throwing (Halverson & Roberton, 1978; Leme & Shambes, 1978; Roberton, 1977, 1978).

Investigations of other motor skills result in similar findings. VanSant (1988), for example, identified 13 modal movement profiles used by healthy adults as they moved from supine to standing. The single, most common form of rising, used by only 25% of her subjects, did not include the most advanced developmental level of movement for each body component. The results of this study suggest that not everyone reaches the most advanced developmental level in

performing righting tasks.

Alternately, it is also possible that the subjects in VanSant's study had already begun a developmental regression process. Developmental regression refers to the age related decline in physical functioning which is assumed to occur according to the traditional model of neurodevelopment. Regardless, performance of the same movement action resulted in qualitative differences from person to person. Therefore, while righting behaviors are observed universally, the actual movement patterns used vary between individuals. The similarities in development which represent the foundation of motor development theory are combined with a spectrum of uniqueness.

While changes in movements are age-related, the identification of age-appropriate movement patterns in adulthood is confounded by the vast diversity seen in older adults (Birren, 1964). Rowe and Kahn (1987) noted cultural differences in age-linked increases in blood pressure, body weight, and serum cholesterol levels. In addition, extrinsic factors such as diet and exercise act as moderators of the aging process. Many changes occurring in adulthood take place over a wider time span than that in childhood. Little information is available on sequential motor development during adulthood to the

end of the life-span.

Presumably, righting behavior is naturally occurring, develops early in life, and remains stable throughout the entire lifespan of healthy individuals (Gesell, 1940, 1946; McGraw, 1945; Schaltenbrand, 1927). Changes in righting behaviors are the result of early experiences in infancy which enable bipedal locomotion and an independent erect posture (McGraw, 1945). As such, these righting behaviors may be less suseptible to environmental alterations. However, Zelazo et al, (1972) found that active exercise of reflex stepping during infancy, accelerated acquisition of walking. Baer (1973) noted that normal behaviors in preschool children have been modified in motor, social, and cognitive domains by environmental interventions. Thelen (1984) described characteristics that contribute to the expression of certain motor patterns. She called factors such as weight, strength, and size, "rate limiters" or body-related constraints on movement. Findings by these researchers indicates that righting behaviors are influenced and altered by many variables, some of which are external. Deceleration of the developmental regression process assumed to exist in adulthood may be possible through use of exercise (Zelazo, 1972) or by changing body build constraints on movement (Thelen, 1984).

The Component Approach

Roberton (1978) applied criteria of stage theory to movement descriptions of a forceful overarm throw. She described a predictable sequence of motor accomplishments in various age groups performing this task. The movement changes observed by Roberton were temporally invariant, universal, and hierarchical in nature.

In an attempt to describe accurately the forceful overarm throw, Roberton (1977,1978) found that total body action descriptions inadequately and inaccurately accounted for the movement patterns she observed. Different regions of the body changed at different rates so that the arms might show a more developmentally advanced movement pattern than the legs on the same individual. These different levels of development made it difficult to categorize subjects' actions using a single, total body category. Consequently, she formulated the method of movement description known as the component approach (Roberton, 1977,1978), which attempts to describe actions of specific body regions within the context of the total body movement. Each body component is viewed as an integral part of the entire motor pattern.

Roberton and Halverson (1984) outlined component

descriptions for fundamental motor skills important to physical educators. Some of the developmental descriptions were hypothesized using cross-sectional data while others have been validated longitudinally. For example, the developmental description of hopping is divided into two movement components: leg action and arm action. The leg action component has four developmental levels from the least advanced, momentary flight level to the most advanced, projection delay/swing leg leads level. The arm action component has five developmental levels beginning with the least advanced, bilateral inactive level to the most advanced, opposing-assist level. The developmental sequence for hopping was partially validated (Halverson & Williams, 1985) using a prelongitudinal screening procedure. Each developmental level is accompanied by a thorough qualitative description of that component movement pattern. Therefore, the component sequences provide great detail in movement pattern descriptions.

Developmental sequences are initially derived following an exhaustive literature review of the movement pattern of interest. The first stage of the validation process requires testing the hypothesized sequence against cross-sectional data. Enough age groups are identified to maximize the possibility of

observing each hypothesized behavior. The order of developmental levels arises by noting frequency of occurrence of a behavior with respect to age (Roberton, Williams, Langendorfer, 1980).

Roberton, Williams, and Langendorfer (1980) designed a research method known as prelongitudinal screening. Various age groups are observed performing a given task. Younger subjects are expected to perform the task most frequently using actions described by lower developmental levels of the sequence. The older subjects are expected to perform the task most frequently using more advanced developmental actions of the sequence. Evaluating frequencies of occurrence of body actions for different age groups helps to validate the developmental sequence. Thus, sequences which withstand the prelongitudinal screening evaluations are ready for longitudinal research. Confirmation of true developmental change can only be ascertained using a longitudinal research design.

Righting Actions

Only recently has the component approach been implemented in descriptions of righting reactions (VanSant, 1983, 1988; Richter, 1985; Lewis, 1986; Sarnacki, 1985; Francis, 1986). VanSant (1983,1988) filmed children and young adults performing the task of

coming from a supine position to erect stance. She proposed a developmental sequence for this righting task. Some forms of the righting action not seen in adults were commonly observed in children. Children demonstrated a wider range of rising movements compared to adults. Thus, qualitative changes associated with the same movement pattern were not only age related, but demonstrated the individual variation and uniqueness of movement patterns.

Age differences have been observed in other righting actions. Richter (1985) used the component approach to hypothesize a developmental sequence for rolling from supine to prone in adults. Richter found a large number of different component combinations for this movement pattern with the modal profile for rolling seen in less than 12% of the trials analyzed. Lewis (1986) revised the developmental sequence for rolling as she studied children aged 6, 8, and 10 years. Although Lewis found the same modal profile in all the age groups she studied, the incidence of movement pattern combinations did vary with age. Sarnacki (1985) described adults rising from supine on a bed and hypothesized developmental sequences using the component approach. Sarnacki found only 10% of all trials were characterized by the most common combination of

component action. Francis (1986) established an hypothesized developmental sequence for the action of sit-to-stand in children and adults. Combinations of component action patterns did vary with age. Additionally, fifty-two different movement pattern combinations were observed.

The findings of the above studies (Francis, 1986; Lewis, 1986; Richter, 1985; Sarnacki, 1985; VanSant, 1983,1988) suggest that some individuals may not reach the most advanced developmental levels of movement for righting behaviors. For example, five out of the 25 subjects in VanSant's study performed the rising task using upper extremity action category (C) symmetrical push, axial category (D) symmetrical, and lower extremity category (B) asymmetrical/wide-base squat. Upper extremity action (C) and lower extremity action (B) are less advanced in the developmental sequence. These body actions represented the second most common form of rising observed in VanSant's sample. Furthermore, differences between individual patterns of movement reinforce the notion of great heterogeniety present in the adult population. Although the ability to perform righting behaviors is intact in healthy humans, the method by which these movement patterns are performed can vary from person to person.

The Role of Activity Level

The process of aging typically involves physiological degeneration related to the passage of time. Bortz (1982) compared the effects of aging and the effects of forced physical inactivity (i.e. bedrest) on individual health status and biological condition. He found a strong correlation between disuse and decline in physiological processes. In contrast, Smith (1982) noted exercise as a useful tool in the prevention of bone loss associated with aging when he tested elderly adults before and after involvement in a regular exercise program. Aisenbrey (1987) also pointed out that bone atrophy with aging was directly related to activity levels. These investigations and others suggest physical exercise may actually remediate biological decrements or, at least, diminish the rate of decline (Aisenbrey, 1987; Bortz, 1982; Leuhring, 1988; Montoye, 1975; Rowe & Kahn, 1987; Shephard, 1987; Smith, 1982).

Leuhring (1988) evaluated differences in the quality of movement among an elderly group of adults (mean age 70) performing the task of coming from a supine position to erect stance. More active individuals moved at a developmentally more advanced level than less active persons. The more active group

demonstrated a level of physical function commonly associated with younger age groups (Leuhring, 1988).

Energy expenditure in leisure activities was studied by Montoye (1975). He examined an entire community over a ten year period. The types of leisure activities chosen by individuals did not change with age whereas the time spent in those activities did decrease. These findings were particularly true for activities requiring vigorous exertion and includes lawn mowing, walking, hunting, golf, bowling and swimming.

Palmore (1982) examined predictors of longevity among a group of elderly persons. Palmore's Duke Longitudinal Study included a functional activity assessment based on social and economic resources, physical and mental health, and activities of daily living. Palmore (1982) found a correlation between general activity levels and reports of life satisfaction and health.

Shephard (1987) noted that signs of pathological vascular changes occur within the first decade of life as fatty streaks appear in the aorta. Fibrous plaques can be found in human vessels beginning with the second decade of life. General exercise counteracts the detrimental effects of these vascular changes by increasing collateral blood flow and circulation systemically. Thus, both central blood flow to the

vital organs in increased (i.e. heart) as well as the increase in peripheral blood flow.

Many orthopedic problems present in old age, such as degenerative arthritis and discomfort in the lower extremity joints and back, are associated with obesity (Shephard, 1987). Energy cost of movement is increased by a greater body mass, which includes a greater respiratory workload. Optimum treatment of obesity involves an appropriate combination of dietary management and regular exercise (Shephard, 1987). Exercise has many advantages over dietary restrictions in that body fat is decreased, metabolism increases, muscle strength improves, bone density increases, and mood elevation occurs (Aisenbrey, 1987; Shephard, 1987; Smith, 1982). Therefore, weight control and physiological improvements result from ongoing involvement in a regular exercise program.

Summary

Contrary to the traditional viewpoint of developmental changes as a representation of the neurodevelopmental maturation process, recent research indicates environmental influences as crucial factors in the rate and extent of developmental change. While the role of physical activity in affecting qualitative

changes in movement patterns is partially understood, a paucity of information on patterns of normal movement in adulthood creates a void for understanding how activity alters the quality of movement.

The component approach offers a thorough, qualitative view of motor skills by identifying actions performed by regions within the body. Thus, developmental sequences from the least mature to the most mature form of movement can be identified for a particular task. Normative data on adult movement patterns can be obtained, which offers a developmental explanation of variability, compatible with sufficient consistency for discernible sequences.

In addition, movement patterns, referred to as righting behaviors, were previously assumed to be developmentally "mature" in all adults. Actually, righting behaviors are examples of the wide range of differences seen between individuals performing the same task. VanSant (1983; 1988) and her colleagues identified large differences in how persons moved while performing the same motor tasks. For example, only 25% of VanSant's (1988) subjects performed using the modal profile of the rising movement pattern and only 12% of Richter's (1985) subjects demonstrated the most common form of rolling. Francis found 52 different movement pattern combinations when analyzing children and adults

performing the movement of sit-to-stand. Because righting behaviors are considered to be automatic, lifelong tasks, the factors that influence the quality of movement require study.

Lack of developmental maturity in all body regions may be associated with previous life experiences. Leme and Shambes (1978) and Halverson and Roberton (1979) suggest that issues of motivation, socialization, cultural background, practice, and experience contribute to how a person performs motor tasks such as a forceful overarm throw. Piaget (1972) described individual differences steming from personal aptitudes.

Because people in this society are demonstrating increasing longevity, special interest has emerged in ways to diminish the rate of physiological decline associated with aging. Many accounts of factors extrinsic to the aging process are identified which alter the rate and degree of physiological decline (Aisenbrey, 1987; Bortz, 1982; Rowe et al, 1987; Shephard, 1987; Smith, 1982). Research demonstrates that a link exists between level of physical activity and health. General exercise appears to be among the influencing factors in the dynamic status of the aging human.

Neurodevelopmental changes throughout the life

course are apparent. The effects of neurological alterations in the aging process on movement patterns have not been defined. Factors influencing efficient movement are currently under investigation.

CHAPTER 3

Methodology

INTRODUCTION

This chapter describes the subjects, the activity level questionnaire, and the hypothesized sequence for the movement pattern from a supine position to erect stance. Procedures, filming methods, and data analysis also are discussed.

Subjects

Seventy-two adults between the ages of 30-39 years, from the campus of Kansas State University and the community of Manhattan, Kansas served as subjects. Announcements to adult fitness classes at Kansas State University and notices posted across campus advertised the study. In addition, newspaper advertisements helped to recruit subjects. Subjects characterized by distinct levels of activity (high and low) were sought. High activity level subjects came from the adult fitness program at Kansas State University and low activity level subjects came from the general Manhattan, Kansas adult population. The subjects provided written consent for their participation in this study prior to testing (Appendix A).

Activity Level Questionnaire

The activity level questionnaire (Appendix B) consisted of a multiple-choice format of self-rated health status and activity information. The questionnaire also contained information pertaining to the employment history of the subject. In addition, subjects gave a brief account of their participation in vigorous physical activities such as running, biking, basketball, or tennis, during their entire life span. They specified the types of activities in which they were involved by selecting from a list of choices. Subjects also were asked to add activities not on the list (Appendix B).

The division of the sample into three groups came from responses to questions on the activity level questionnaire. Five frequency of participation choices were given, and ranged from almost every day (at least five times a week) to almost never. Group 1 consisted of 25 subjects who reported daily participation in vigorous physical activity. Group 2 consisted of 26 subjects who reported that they participated in vigorous physical activity once or twice a week. Group 3 consisted of 21 subjects who said they participated in vigorous physical activity only occasionally or rarely (Appendix C). Subjects chosen reported no acute or

chronic physical or medical conditions that might have interfered with their level of physical activity.

Movement Evaluation Instrument

The rising movement was categorized using VanSant's (1988) hypothesized component sequence (Appendix D). VanSant (1988) divided the body actions occurring during the movement from supine to standing into three component categories: 1) upper extremities (UEs), 2) axial (head-trunk) region, and 3) lower extremities (LEs). The component actions are qualitative descriptions and appear in a hierarchical developmental sequence of movement.

The developmental sequences for the three body components begin with least advanced asymmetrical body actions, progressing to more advanced symmetrical actions. The component actions described first in the sequence are the least advanced developmentally while the subsequent component descriptions represent progression towards the most developmentally advanced body actions (Appendix D). Initially, an individual who is coming from supine to standing demonstrates the lower developmental levels before progressing to the more advanced levels. Separate individuals may be characterized by different developmental levels for each component. For example, an individual might incorporate

asymmetrical upper extremity and axial movements with symmetrical lower extremity movements. The total body action, known as a profile, could consist of different developmental levels of movement for each body component.

Not all actions have been found to characterize all age groups. VanSant (1988) noted that children perform an axial action of full trunk rotation with their abdomen contacting the support surface (full rotation, abdomen down) while adults have not been observed to demonstrate this action. Component sequences discussed are appropriate to adult populations and do not include movement descriptions that are unique to periods of infancy and childhood (Appendix D).

<u>Upper Extremity Component</u>

Four action descriptions comprise the developmental sequence for the UE component. The least advanced developmental movement pattern for the UE component involves an asymmetrical arm action. One arm pushes off the support surface while the other reaches forward across the body and then is placed so that both hands push simultaneously against the support surface (A-push & reach to bilateral push). The developmental progression of this component action ends in the most advanced movement where a symmetrical bilateral reach

(D) of both arms occurs to assist in balance throughout the movement.

VanSant subdivided the least advanced A category into two actions. Distinction between the A category and the A' category results from the final arm action of pushing on the leg. Otherwise, these actions are virtually identical. Likewise, the B category (push and reach) is primarily the same UE action as the B' category (push and reach followed by pushing on leg). These two categories also differ in hand contact with the leg at the end of the movement pattern. For this investigation, occurrence of the A category (push and reach to bilateral push) was combined with the A'category (push and reach to bilateral push followed by pushing on the leg). Occurrence of the B category actions (push and reach) also were combined with the B'category (push and reach followed by pushing on the leg). Categories were combined due to similarity of the arm actions. Collapsing allowed the investigator to identify accurately developmental levels without sacrificing detailed information.

Axial Component

The axial component consists of four separate actions, beginning with the least advanced, full rotation, abdomen up (A). This pattern involves

complete trunk rotation so that the ventral surface of the trunk faces, but does not contact the support surface. The pelvis then is elevated to or above the level of the shoulder girdle while the back extends vertically. The most advanced movement pattern of the axial component involves symmetrical trunk flexion past the vertical plane followed by back extension to an upright position.

When the arms move asymmetrically, the trunk action accompanies that asymmetry and reflects some degree of rotation. The amount of rotation determines the developmental progression in this sequence with greater rotation involved in the lower developmental levels and lesser rotation as one progresses developmentally. The most advanced axial movement involves symmetrical trunk flexion to elevate to standing.

Lower Extremity Component

The LE component has five different movement actions beginning with the least advanced kneel pattern (0). The asymmetrical lower extremity kneel pattern involves bilateral lower extremity flexion toward the trunk followed by rotation of both knees to one side. Both knees contact the support surface and lead to a half kneeling or squat pattern. The lower extremities extend to elevate the individual to an upright position.

The most advanced pattern, narrow base symmetrical squat (C), involves symmetrical flexion of the legs with the heels approximating the buttocks in a narrow base squat. From this position, the legs extend and the body is elevated to an upright position.

The developmental sequence for the lower extremity is presented in hierarchical fashion with the exception of the jump to squat category (Appendix D). VanSant (1988) identified two categories, the kneel (O) and the jump to squat (N), which were previously not in hierarchical order in the developmental sequence. In this study, the kneel (the double kneel action) category was hypothesized to precede the half kneel category because the double kneel action involves greater asymmetry of movement than the half kneel. Thus, the motor action involving more asymmetry (double kneel) precedes the single kneel (half kneel) category. Using symmetrical criteria to identify more advanced developmental movements suggests the current ordering of categories O and A. The jump to squat category, however, appears to be exceptional and was placed at the end of the sequence. This placement does not imply the jump to squat is the most advanced developmental level. Hierarchical placement of the jump to squat category remains to be determined by future research.

Procedures

Prior to filming, anthropometric measurements were recorded for each subject. Biacromial width, arm length, bicristal width, leg length, and sitting height were measured. Height, weight, and circumference measurements of head, chest, hip, and thigh also were obtained (Appendix E).

After receiving verbal instructions, subjects assumed a supine position on a mat at a designated location (an "X" marking) with their arms at their sides. Subjects were told to stand up as quickly as possible, following a "Go" command for each trial. The instruction to stand quickly facilitated automaticity of the subjects' movements. An opportunity to do a practice trial was given; most subjects opted not to take a practice trial. To prevent a bias in the movement pattern used, no physical demonstration of rising occurred. Verbal instructions were given so that subjects would not imitate a demonstration of the movement pattern. Subjects performed 10 trials of the movement pattern of rising from a supine position to erect stance while being videotaped. Intermittent use of praise such as "Good" or "Great" served as a motivational tool. The between trial interval, self-paced by each subject, generally lasted only a few

seconds. Subjects wore shorts and tee shirts to allow for better viewing of the movement pattern.

Filming Methods

Two portable videocameras were used to film the movement pattern. One camera obtained a lateral view of each subject while the other camera obtained a frontal view. Both cameras were set on tripods such that the optical axis of each camera was perpendicular to the side of the mat at a height of 1 m above the floor. The lateral view videocamera, an Everex color camera Model TU-69U, obtained 30 images per second and was located 8.7 m from the center of the exercise mat. The frontal view camera, a Panasonic autofocus omni movie VHS HQ Model PV-320D, obtained 30 images per second and was located 6.3 m from the center of the exercise mat.

Data Reduction

Each trial was viewed and reduced using an Everex model TU-69U videodeck with slow motion, pause, single frame advancement, and rewind capabilities. These features of the videodeck enabled the investigator to view and re-view the movement as needed. The rising movement patterns were categorized using VanSant's (1988) hypothesized component sequence. Copies of both

lateral and frontal views of the movement served to confirm actions not clearly visible on one camera or the other.

The author and a trained rater classified 50 randomly selected trials of the subjects' performances to estimate inter-rater reliability. In addition, the investigator randomly reviewed and reclassified 50 trials to estimate intra-rater reliability.

The investigator screened the trials for the existence of any additional categories beyond those hypothesized by VanSant (1988). In evaluating the comprehensiveness of VanSant's hypothesized sequence, further validation was made regarding the developmental sequence of the rising movement pattern.

Roberton (1978) noted that any variation in movements done by the same individual should occur only to adjacent developmental levels. This adjacency criterion allows for a verification of the order of the hypothesized developmental sequence. Roberton's (1978) research procedure of validating the developmental sequence is a prelongitudinal screening process done prior to the investment of time and expense in longitudinal research.

The data in this investigation were examined using the technique of prelongitudinal screening described by Roberton, Williams, and Langendorfer (1980). After the

developmental sequence has been hypothesized from a review of the literature, cross-sectional data are used to identify the least mature to the most mature levels of movement. Then, subjects of differing ages are asked to perform a specific movement and the order of the sequence is used to evaluate whether subsequent developmental levels are appropriately modal. In other words, motor stage theory predicts that in younger populations the existence of lower developmental movement patterns should predominate, while subsequent patterns will predominate in an appropriate age-related manner. This method is used to ensure adequate evaluation of the developmental sequence prior to longitudinal research investments.

All trials for the upper extremity component were categorized, followed by the axial component, then the lower extremity component for all subjects (Appendix F). The percentages of occurrence of each category were tabulated for the separate components. The frequency of each subject's arm/trunk/leg combination across trials was used to determine a modal profile for each subject. The investigator also determined the modal category for each component across subjects.

Data Analysis

The data were summarized and analyzed to compare the three groups. The comparison was based on frequency of occurrence of each category for each body component. Descriptive analysis used to compare the sample groups enabled the investigator to identify an association between activity levels and the developmental movement patterns used to elevate to a standing position. The information gathered from the activity level questionnaire served to verify levels of participation in vigorous physical activity for assignment to the appropriate sample group.

Chapter 4

RESULTS

Data are summarized and displayed for the three activity level groups according to subject characteristics, percentages of occurrence of categories within the components and across trials, and the distribution of trials for each component. Modal profiles across subjects and comparisons between modal profiles and activity level patterns are presented. A descriptive analysis is included using frequency of occurrence data.

Subject Characteristics

Thirty-three males and 39 females participated in this study with the mean age of 35.5 years old.

TABLE 1
Subject Characteristics

(n=72)

		N	AGE(yrs.)	HEIGHT(cm)	WEIGHT(kg)
GROUP 1 (daily)	male	13	35.9	177.6	76.1
	female	12	36.1	164.9	57.4
GROUP 2 (1-2x/wk)	male	13	36.1	182.1	81.4
	female	13	35.4	166.5	62.4
GROUP 3 (rarely)	male	7	34.7	184.2	86.8
	female	14	34.2	168.9	68.8

Group 1 (daily) consisted of 25 subjects, 13 male and 12 female, who reported current involvement in vigorous physical activity on a daily basis. Group 2 (1-2x/wk) had 26 subjects, 13 male and 13 female, reporting involvement in vigorous physical activity at least once or twice a week. Group 3 (rarely) was made up of 21 subjects, seven males and 14 females, who reported rarely participating in vigorous physical activity (Table 1 & Appendix A).

Analysis of variance was used to compare group differences with regard to weight, height, age, and sex. None of the comparisons yielded statistically significant differences; weight $F(2, 69) = .646$, $p > .05$, height $F(2, 69) = 2.384$, $p > .05$, age $F(2, 69) = 2.384$, $p > .05$, sex $F(2, 69) = .928$, $p > .05$.

Rater Objectivity

Levels of exact agreement between the investigator and a trained rater of at least 85%, represented acceptable objectivity for categorizing the component actions (VanSant, 1988). Component actions for the three body segments were independently categorized in a set of 50 randomly selected trials. Inter-rater percentage of agreement was 96% for both the upper extremity and axial categories and 88% for the lower

extremity category. The same 50 trials were classified on two separate occassions by the investigator in order to determine intra-rater objectivity. Intra-rater percentages of agreement were 98% for the upper extremity component, 96% for the axial component, and 85% for the lower extremity component.

Analysis of Movement Components

No new behaviors beyond those described by VanSant (1988) were observed in this sample. Therefore, the categories were assumed to be comprehensive. VanSant's (1988) hypothesized developmental sequences for rising adequately described the movements observed in all the subjects tested.

Occurrence of Categories

Each subject performed 10 trials of the supine to standing movement pattern. Group 1 (daily) included 25 subjects, or 250 trials, Group 2 (1-2x/wk), 26 subjects, or 260 trials, and Group 3, 21 subjects, or 210 trials for analysis. Seven hundred and twenty trials comprised this study. The frequency with which each movement pattern appeared across trials and subjects for each of the three activity level groups is presented in Table 2.

TABLE 2

Percentage of Occurrence Across Trials
For Component Categories
(n=720 trials)

UPPER EXTREMITY CATEGORY	Pattern of Activity GROUP 1 (daily)	GROUP 2 (1-2X/wk)	GROUP 3 (rarely)	COMBINED GROUPS
A-push & reach to bilateral push	10.4 (26)	11.50 (30)	12.4 (26)	11.4 (82)
B-push & reach	51.2(128)	44.25(115)	61.9(130)	51.8 (373)
C-bilateral push	38.4 (96)	44.25(115)	25.2 (53)	36.7 (264)
D-bilateral reach	0.0 (0)	0.0 (0)	.5 (1)	0.1 (1)
TOTAL	100.0(250)	100.0 (260)	100.0(210)	100.0 (720)

AXIAL CATEGORY	Pattern of Activity GROUP 1 (daily)	GROUP 2 (1-2X/wk)	GROUP 3 (rarely)	COMBINED GROUPS
A-full rotation abdomen up	6.8 (17)	.4 (1)	9.5 (20)	5.3 (38)
B-partial rotation	6.0 (15)	3.8 (10)	16.6 (35)	8.3 (60)
C-forward with rotation	45.6(114)	48.1(125)	49.1(103)	47.5(342)
D-symmetrical	41.6(104)	47.7(124)	24.8 (52)	38.9(280)
TOTAL	100.0(250)	100.0(260)	100.0(210)	100.0(720)

LOWER EXTREMITY CATEGORY	Pattern of Activity GROUP 1 (daily)	GROUP 2 (1-2X/wk)	GROUP 3 (rarely)	COMBINED GROUPS
O-kneel	0.0 (0)	0.0 (0)	5.7 (12)	1.7 (12)
A-half kneel	3.2 (8)	5.0 (13)	12.4 (26)	6.5 (47)
B-asymmetrical/ wide-base squat	56.8(142)	58.8(153)	59.5(125)	58.3(420)
C-narrow base symmetrical squat	32.8 (82)	36.2 (94)	17.6 (37)	29.6(213)
N-jump to squat	7.2 (18)	0.0 (0)	4.8 (10)	3.9 (28)
TOTAL	100.0(250)	100.0(260)	100.0(210)	100.0(720)

The UE pattern hypothesized as the least advanced movement in the developmental sequence (A-push & reach to bilateral push) was demonstrated in 10.4% of the trials for the most active Group 1 (daily), while 12.4% of the least active Group 3 (rarely) performed trials at this level. The moderately active Group 2 (1-2x/wk) performed 11.5% of their trials using the least advanced UE movement pattern. The UE component action which is second in the developmental sequence (B-push & reach) was observed in 51.2% of the trials for Group 1 (daily), 44.25% of the trials for Group 2 (1-2x/wk), and 61.9% of the trials for Group 3 (rarely). The B category for the UE component was the most common action demonstrated by each group and was observed in 51.8% of the trials analyzed. The bilateral push (C) upper extremity action was seen in 38.4% of the trials for Group 1 (daily), 44.25% of the trials for Group 2 (1-2x/wk), and 25.2% of the trials for Group 3 (rarely). Only one subject in the entire population demonstrated the most advanced UE movement pattern (D-bilateral reach) and performed this pattern on only one of the 10 trials.

The least advanced axial movement pattern (A-full rotation, abdomen up) appeared in 6.8% of the trials for the most active Group 1 (daily), 0.4% of the trials for the moderately active Group 2 (1-2x/wk), and 9.5% of the trials for the least active Group 3 (rarely). The

second axial component action in the developmental sequence (B-partial rotation) appeared in 6.0% of the trials for Group 1 (daily), 3.8% of the trials in Group 2 (1-2x/wk), and 16.6% of the trials for Group 3 (rarely). The most common axial action observed for all groups was level C, a forward with rotation action which occurred in 47.5% of the 720 trials. Axial category C (forward with rotation), was represented by 45.6% of Group 1 (daily), 48.1% of Group 2 (1-2x/wk), and 49.1% of Group 3 (rarely) trials. The most advanced symmetrical trunk pattern (D-symmetrical) was observed in 41.6% of the trials for the most active Group 1 (daily), 47.7% of the trials for the moderately active Group 2 (1-2x/wk), while only 24.8% of the trials for the least active Group 3 (rarely) were categorized as the symmetrical trunk pattern.

The lower extremity, double kneel pattern (O) was seen in 5.7% of the trials for the least active Group 3 (rarely) while none of the subjects in the other two more active Groups (daily and 1-2x/wk) demonstrated this action. The half kneel (A) category was observed in 3.2% of the trials for Group 1 (daily), 5.0% of the trials for Group 2 (1-2x/wk), and 12.4% of the trials for Group 3 (rarely). The next category in the LE developmental sequence is asymmetrical/wide-base squat

(B). This was the most common action observed for all groups (58.3%). Fifty-six point eight percent of Group 1's (daily), 58.8% of Group 2's (1-2x/wk), and 59.5% of Group 3's (rarely) trials fell into this category. The most advanced narrow base symmetrical squat (C) LE movement appeared in 32.8% of Group 1's (daily) trials, 36.2% of Group 2's (1-2x/wk) trials, while only 17.6% of Group 3's (rarely) trials were categorized as the symmetrical squat action.

Percentages of occurrence and frequency counts combined across all groups for each category show the most common form of rising for the sample, regardless of activity level (Table 2). The most commonly occurring UE component action was the B category (push and reach). The most common axial component action was category C (forward with rotation) while the most common LE component action was category B (asymmetrical/wide base squat).

In each of the three body components, the least active sample, Group 3 (rarely), exhibited the largest percentage of trials placed at the lowest developmental levels of movement. Additionally, these same subjects used the most advanced, symmetrical categories less often than participants in the other two groups. The more active Group 1 (daily) and Group 2 (1-2x/wk) subjects demonstrated comparable percentages of

occurrence in the movement patterns for the three body components (Figures 1-3).

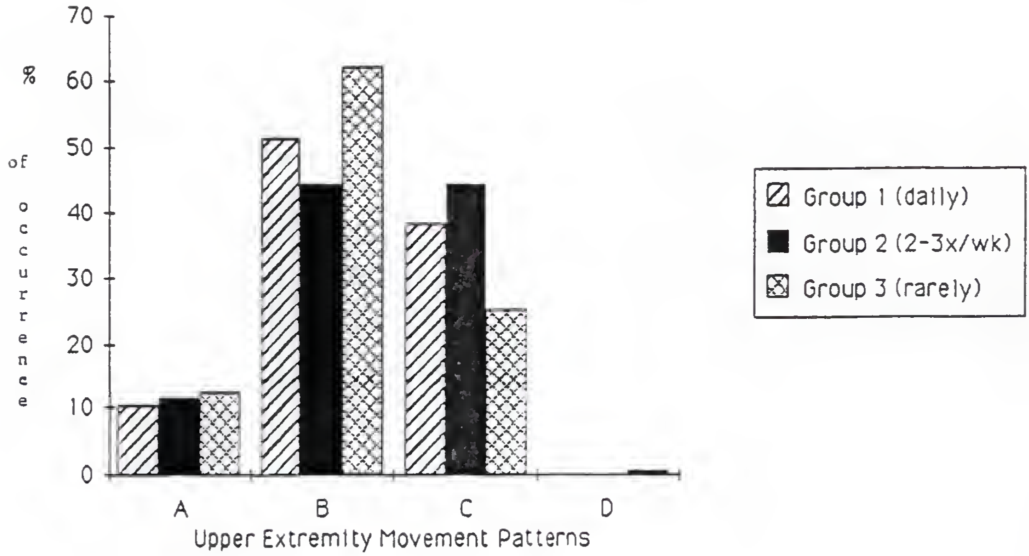

Figure 1. Percentage of occurrence across trials for activity level groups (N = 720)

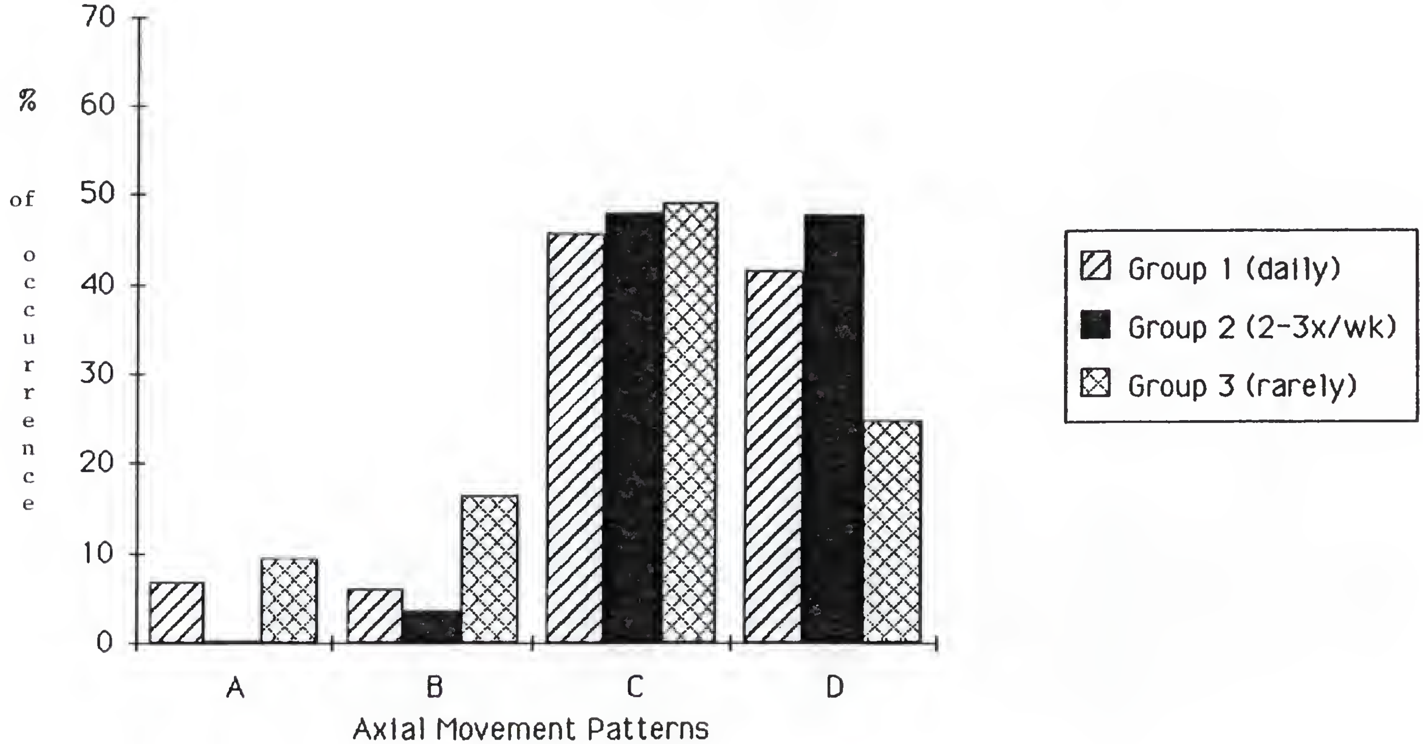

Figure 2. Percentage of occurrence across trials for activity level groups (N = 720 trials)

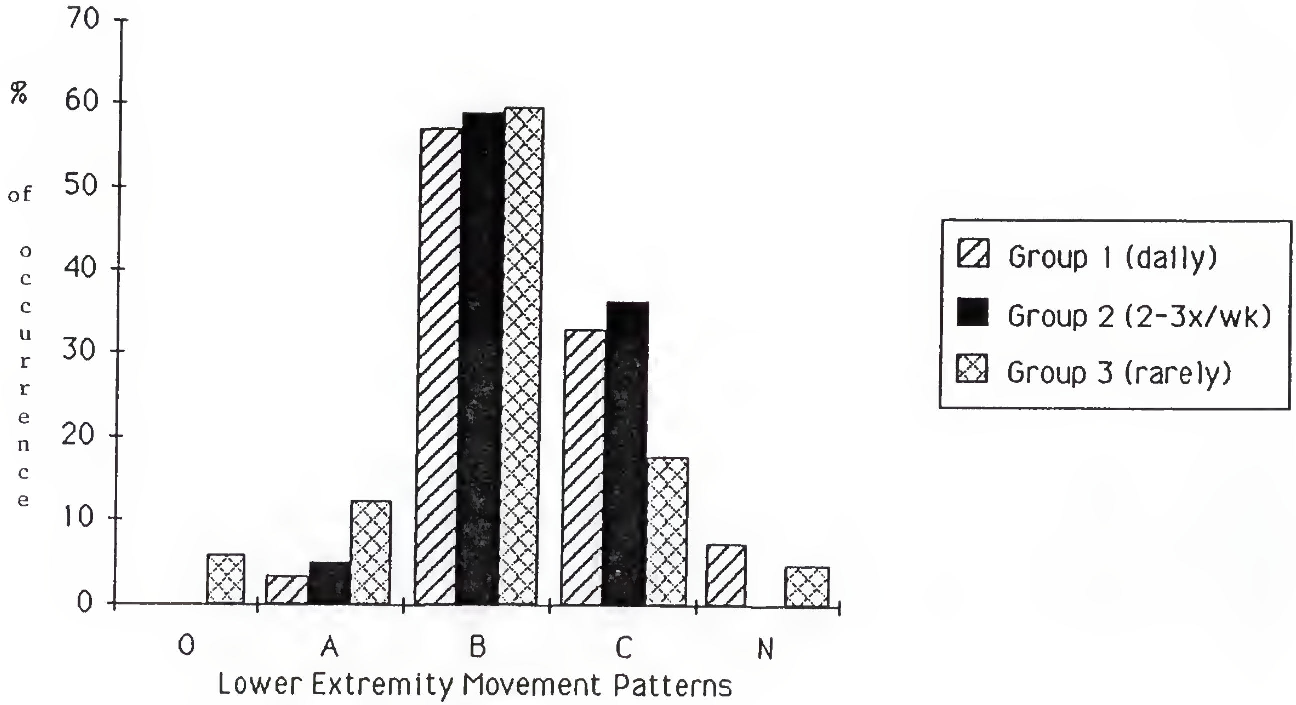

Figure 3. Percentage of occurrence across trials for activity level groups (N = 720 trials)

Movement Pattern Consistency

Subjects demonstrated a high degree of consistency in the movement patterns they used. In general, subjects were categorized at the same developmental level for eight to nine of their 10 trials for each movement component (Table 3). Small activity group differences existed. Subjects in Group 1 (daily) were placed in the same upper extremity category 92% of the time; they used the same axial pattern for 93% of their trials, and the same lower extremity action on 92.6% of the time. Group 2 (1-2x/wk) also demonstrated consistency in the movement patterns they used, with an average of 94.2% of the upper extremity movements, 96.5% of axial component actions, and 91.2% of the lower extremity movements placed in the same categories. The least active Group 3 (rarely) showed the lowest level of consistency compared to the other groups. On the average, 89% of the upper extremity movements were placed in the same level, 83.8% of the axial component actions were the same, and 90% of the LE component movements were categorized at the same level for Group 3 (rarely) participants. Collectively, subjects performed using the same movement patterns on the average of 91.4% of the time.

TABLE 3

Average Percent Performance of Modal Category Movement Pattern

	Pattern of Activity		
Body Region	GROUP 1 (daily)	GROUP 2 (1-2X/wk)	GROUP 3 (rarely)
Upper Extremities	92.0	94.2	89.0
Axial Region	93.2	96.5	83.8
Lower Extremities	92.6	91.2	90.0

Average levels of consistency mask the differences in the actual movement pattern used by subjects. Whatever their pattern, however, subjects demonstrated little variability during the 10 trials they performed of the supine to standing movement pattern. Many subjects in each group were absolutely consistent across all 10 trials: 15 subjects in Group 1 (daily), 16 subjects in Group 2 (1-2x/wk), and 12 subjects in Group 3 (rarely) had all 10 trials categorized in the same UE category (Table 4). Similar consistency in axial movement was observed as 15 subjects in Group 1 (daily), 19 subjects in Group 2 (1-2x/wk), and 10 subjects in Group 3 (rarely) had all 10 trials placed in the same axial category (Table 5). Consistency in the movement patterns of the LE component were reflected by Group 1 (daily) with 15 subjects, Group 2 (1-2x/wk) with 15 subjects, and Group 3 (rarely) with 13 subjects having all 10 trials categorized at a single level (Table 6).

When subjects varied, they most frequently varied only between two adjacent developmental levels and then, nearly always only for one of their trials (Table 4). Some subjects did vary to a greater extent, however. A few subjects had four trials classified in one category and six trials in another. Some subjects demonstrated an equal distribution of trials with five trials in one category and five trials in another category. Identification of which subjects varied, and how often they varied is presented in Tables 4-6.

TABLE 4

Distribution of Trials for Upper Extremity Component

number of subjects demonstrating pattern	number of trials in upper extremity category A	B	C	D
GROUP 1 (daily)				
[illegible]		10		
[illegible]			10	
[illegible]		[illegible]	1	
2		1	9	
2	9	1		
1	4	6		
1	4	5	1	
1		3	7	
1		[illegible]	8	
TOTAL=25				
GROUP 2 (1-2x/wk)				
8			10	
6		10		
3		9	1	
3		1	9	
[illegible]	10			
1		8	2	
1	8	2		
1	2	8		
1		7	3	
TOTAL=26				
GROUP 3 (rarely)				
9		10		
2		4	6	
2			10	
1		7	3	
1	8	2		
1			9	1
1	2	8		
1		2	8	
1	6	4		
1		9	1	
1	10			
TOTAL=21				

One subject in Group 1 (daily) varied between three adjacent developmental categories in the UE component (Table 4) with four trials in category A, five trials in category B, and one trial in category C. One subject in Group 3 (rarely) demonstrated variability of body action between three adjacent axial component categories with eight trials in category A, one trial in category B, and one trial in category C (Table 5).

Other than the one subject in Group 1 (daily) noted above, all other subjects who varied in their UE movements did so only between two adjacent categories. All subjects in the LE component varied only between two adjacent categories. Two subjects, one in Group 1 (daily) and one in Group 3 (rarely) showed an even distribution of variation between adjacent categories with five trials in one category and five trials in another category (Table 6).

One subject in Group 2 (1-2x/wk) demonstrated variation of movement to nonadjacent axial categories with one trial in category A and nine trials in category C (Table 5). This occurrence of nonadjacency was considered an anomaly and was not sufficient evidence to reject the developmental sequence based on lack of adjacency criterion.

TABLE 5

Distribution of Trials for Axial Component

number of subjects demonstrating pattern	number of trials in axial category A	B	C	D
GROUP 1 (daily)				
8				10
7			10	
2			9	1
2			1	9
1	8	2		
1	9	1		
1			6	4
1		1	9	
1		3	7	
1		8	2	
TOTAL=25				
GROUP 2 (1-2x/wk)				
10				10
9			10	
2			1	9
1			8	2
1			9	1
1	1		9	
1			7	3
1		10		
TOTAL=26				
GROUP 3 (rarely)				
5			10	
4				10
2			4	6
1			7	3
1		6	4	
1	8	1	1	
1		3	7	
1		2	8	
1		5	5	
1	9	1		
1			3	7
1	3	7		
1		10		
TOTAL=21				

Table 6

Distribution of Trials for Lower Extremity Component

number of subjects demonstrating pattern	number of trials in lower extremity category O	A	B	C	N
GROUP 1 (daily)					
10			10		
4				10	
3			1	9	
1					10
1			8	2	
1			9	1	
1			4	6	
1			2		8
1		8	2		
1			9	1	
1			5	5	
TOTAL=25					
GROUP 2 (1-2x/wk)					
10			10		
4				10	
3			1	9	
3			8	2	
2			4	6	
1		10			
1		3	7		
1			2	8	
1			9	1	
TOTAL=26					
GROUP 3 (rarely)					
9			10		
3				10	
2			8	2	
1			2		8
1	5	5			
1			7	3	
1		8	2		
1			8		2
1	7	3			
1		10			
TOTAL=21					

Modal Profiles

Modal profiles for each subject were determined by associating the most frequently performed category for each component. Body action profiles represent a complete description of how the body moves, based on a combination of the component actions.

Subjects in group 1 (daily) performed using seven different modal profiles (Table 7). Thirty-six percent of the subjects (9) demonstrated the most common body action profile for rising, consisting of upper extremity action category B (push & reach), axial action category C (forward with rotation), and lower extremity action category B (asymmetrical/wide-base squat). Seven subjects (28%) performed the second most common profile, involving upper extremity action category C (bilateral push), axial action category D (symmetrical), and lower extremity action category C (narrow-based symmetrical squat). Other profiles occurred less often (Table 7).

TABLE 7
Profiles Demonstrated as Modal Performance by Subjects
Group 1 (daily)
(n=25)

Component			Number of subjects
UE	AXIAL	LE	
1) B-push & reach	C-forward with rotation	B-asymmetrical wide-based squat	9
2) C-bilateral push	D-symmetrical	C-narrow-based symmetrical squat	7
3) C-bilateral push	D-symmetrical	B-asymmetrical wide-based squat	3
4) B-push & reach	C-forward with rotation	C-narrow-based symmetrical squat	2
5) A-push & reach to bilateral push	A-full rotation abdomen up	N-jump to squat	2
6) B-push & reach	B-partial rotation	B-asymmetrical wide-based squat	1
7) B-push & reach	C-forward with rotation	A-half-kneel	1

Group 2 (1-2x/week) demonstrated eight different modal profiles, with 31% of the subjects (8) using the most common form of rising. The body action profile most commonly performed by subjects in Group 2 (1-2x/wk) consisted of upper extremity action category B (push & reach), axial action category C (forward with rotation), and lower extremity action category B (asymmetrical/wide-based squat). Seven subjects (27%) performed using the second most common body action profile consisting of UE action category C (bilateral push), axial action category D (symmetrical), and LE action category C (narrow-based symmetrical squat). Other profiles occurred less often (see Table 8).

TABLE 8
Profiles Demonstrated as Modal Performance by Subjects
Group 2 (1-2x/week)
(n=26)

Component			Number of subjects
UE	AXIAL	LE	
1) B-push & reach	C-forward with rotation	B-asymmetrical wide-based squat	8
2) C-bilateral push	D-symmetrical	C-narrow-based symmetrical	7
3) C-bilateral push	D-symmetrical	B-asymmetrical wide-based squat	4
4) A-push & reach to bilateral push	C-forward with rotation	B-asymmetrical wide-based squat	2
5) B-push & reach	C-forward with rotation	C-narrow-based symmetrical	2
6) A-push & reach to bilateral push	C-forward with rotation	A-half-kneel	1
7) B-push & reach	B-partial rotation	B-asymmetrical wide-based squat	1
8) B-push & reach	D-symmetrical	C-narrow-based symmetrical	1

Group 3 (rarely) was characterized by 10 different modal profiles, although 33% of the subjects performed the most common form of rising. Seven subjects demonstrated the most common body action profile of upper extremity action category B (push & reach), axial action category C (forward with rotation), and lower extremity action category B (asymmetrical/wide-based squat). The second most frequently performed profile consisted of upper extremity action category C (bilateral push), axial action category D (symmetrical), and lower extremity action category B (asymmetrical/wide-based squat) performed by four subjects (19%) in Group 3 (rarely) (Table 9).

TABLE 9
Profiles Demonstrated as Modal Performance by Subjects
Group 3 (rarely)
(n=21)

Component			Number of subjects
UE	AXIAL	LE	
1) B-push & reach	C-forward with rotation	B-asymmetrical wide-based squat	7
2) C-bilateral push	D-symmetrical	B-asymmetrical wide-based squat	4
3) C-bilateral push	D-symmetrical	C-narrow-based symmetrical	2
4) B-push & reach	B-partial rotation	A-half-kneel	2
5) A-push & reach to bilateral push	B-partial rotation	O-kneel	1
6) B-push & reach	C-forward with rotation	C-narrow-based symmetrical	1
7) A-push & reach to bilateral push	A-full rotation abdomen up	B-asymmetrical wide-based squat	1
8) A-push & reach to bilateral push	A-full rotation abdomen up	N-jump to squat	1
9) B-push & reach	C-forward with rotation	A-half kneel	1
10) B-push & reach	B-partial rotation	B-asymmetrical wide-based squat	1

The most frequently appearing body action profile (UE category B-push & reach, axial category C-forward with rotation, and LE category B-asymmetrical/wide-base squat) was the same for the three groups. However, the second most common body action profile was the same only for the more active groups (daily and 1-2x/wk) and consisted of upper extremity action, bilateral push (C), axial action, symmetrical (D), and lower extremity action, narrow-base symmetrical (C). Group 3 (rarely) subjects often performed using the same upper extremity (C) and axial (D) actions, with a lower developmental level lower extremity action (B-asymmetrical/wide-based squat).

The three most common forms of rising for the entire sample are illustrated in Figures 4-6. Twenty-four subjects performed using the most common profile (Figure 4) with UE component action category B (push & reach), axial component category C (forward with rotation), and LE component action category B (asymmetrical/wide-based squat). Sixteen subjects performed the second most common form of rising (Figure 5), with UE component action category C (bilateral push), axial component action category D (symmetrical), and LE component action category C (narrow base symmetrical squat). Eleven subjects performed using the third most common form of rising (Figure 6) with UE

component action category C (bilateral push), axial component action category D (symmetrical), and LE component action category B (asymmetrical/wide-base squat).

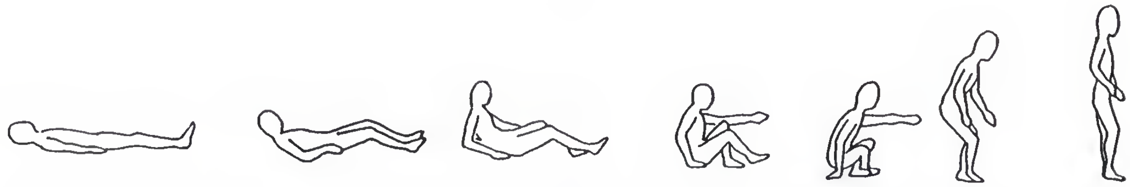

Figure 4. The most common form of rising for adults 30-39 years (N=72)
Upper Extremity Component action- B- push & reach
Axial Component action- C- forward with rotation
Lower Extremity Component action- B- asymmetrical/wide-base squat

NUMBER OF SUBJECTS DEMONSTRATING THIS BODY ACTION PROFILE
Group 1- 9
Group 2- 8
Group 3- 7

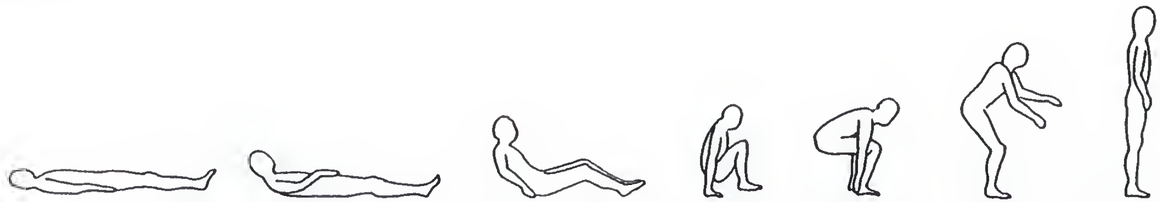

Figure 5. The second most common form of rising for adults 30-39 years (N=72)
Upper Extremity Component action- C- bilateral push
Axial Component action- D- symmetrical
Lower Extremity Component action- C- narrow base symmetrical squat

NUMBER OF SUBJECTS DEMONSTRATING THIS BODY ACTION PROFILE
Group 1- 7
Group 2- 7
Group 3- 2

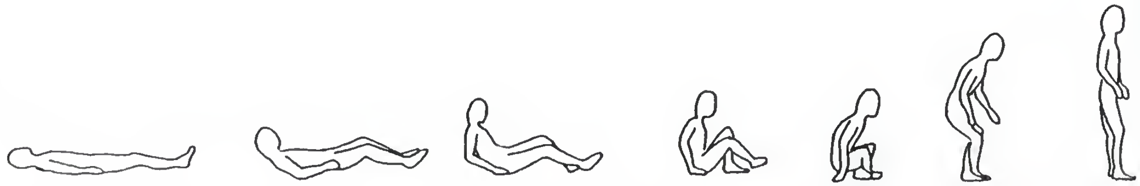

Figure 6. The third most common form of rising for adults 30-39 years (N=72)
Upper Extremity Component action- C- bilateral push
Axial Component action- D- symmetrical
Lower Extremity Component action- B- asymmetrical/wide-base squat

NUMBER OF SUBJECTS DEMONSTRATING THIS BODY ACTION PROFILE

Group 1- 3
Group 2- 4
Group 3- 4

Table 10

Frequency of Occurrence of Modal Component Categories
(n=72)

UPPER EXTREMITY CATEGORY	Pattern of Activity GROUP 1 (daily)	GROUP 2 (1-2x/wk)	GROUP 3 (rarely)	TOTALS
A-push & reach to bilateral push	2 (8%)	3 (12%)	3 (14%)	8(11%)
B-push & reach	13 (52%)	12 (46%)	12 (57%)	37(51%)
C-bilateral push	10 (40%)	11 (42%)	6 (29%)	27(38%)
D-bilateral reach	0 (0%)	0 (0%)	0 (0%)	0 (0%)
TOTALS	25(100%)	26(100%)	21(100%)	72(100%)

AXIAL CATEGORY	Pattern of Activity GROUP 1 (daily)	GROUP 2 (1-2x/wk)	GROUP 3 (rarely)	TOTALS
A-full rotation abdomen up	2 (8%)	0 (0%)	2 (10%)	4 (6%)
B-partial rotation	1 (4%)	1 (4%)	4 (19%)	6 (8%)
C-forward with rotation	12 (48%)	13 (50%)	9 (43%)	34(47%)
D-symmetrical	10 (40%)	12 (46%)	6 (28%)	28(39%)
TOTALS	25(100%)	26(100%)	21(100%)	72(100%)

LOWER EXTREMITY CATEGORY	Pattern of Activity GROUP 1 (daily)	GROUP 2 (1-2x/wk)	GROUP 3 (rarely)	TOTALS
O-kneel	0 (0%)	0 (0%)	1 (5%)	1 (1%)
A-half kneel	1 (4%)	1 (4%)	3 (14%)	5 (7%)
B-asymmetrical/ wide-base squat	13 (52%)	15 (58%)	13 (62%)	41(57%)
C-narrow base symmetrical squat	9 (36%)	10 (38%)	3 (14%)	22(31%)
N-jump to squat	2 (8%)	0 (0%)	1 (5%)	3 (4%)
TOTALS	25(100%)	26(100%)	21(100%)	72(100%)

Less active adults in this sample were categorized more frequently at lower developmental levels than their more active counterparts. Between group comparisons of frequency of occurrence of modal categorizations for each component revealed this trend. Fewer Group 3 (rarely) subjects were placed in the more advanced component action categories in all body components.

Three subjects from Group 3 (rarely) performed using the least advanced developmental level (A-push & reach to bilateral push) of upper extremity action while two subjects from Group 1 (daily) and three subjects from Group 2 (1-2x/wk) demonstrated category A. However, the most advanced upper extremity category action used by this sample was C (bilateral push). Ten subjects in Group 1 (daily), 11 subjects in Group 2 (1-2x/wk), and only six subjects in Group 3 (rarely) had their upper extremity modal action placed in C category. While 40% of the more active Group 1 (daily) and 42% of the moderately active Group 2 (1-2x/wk) performed their UE modal action using category C (bilateral push), only 29% of Group 3 (rarely) performed using category C.

Two subjects in Group 3 (rarely), no subjects in Group 2 (1-2x/wk), and two subjects in Group 1 (daily) were categorized as level A (full rotation, abdomen up), the least advanced axial action. The most advanced symmetrical trunk action (D) appeared as modal

performance in only six subjects in Group 3 (rarely) while 10 subjects in Group 1 (daily) and 12 subjects in Group 2 (1-2x/wk) demonstrated the symmetrical trunk action. Again, while 40% of the more active Group 1 (daily) and 46% of the moderately active Group 2 (1-2x/wk) performed using the most advanced trunk action (symmetrical), only 28% of Group 3 (rarely) were classified in category D.

One inactive subject (Group 3-rarely) demonstrated the least advanced modal LE action category O (kneel). Modal descriptions for none of the other subjects were represented by LE category O. The most advanced LE component action category C (narrow base symmetrical squat) appeared as modal performance for nine subjects from Group 1 (daily), 10 subjects from Group 2 (1-2x/wk), and only three subjects from Group 3 (rarely). While 36% and 38% of the more active Group 1 (daily) and Group 2 (1-2x/wk), respectively, performed modally using LE category C, only 14% of the subjects in Group 3 (rarely) performed modally in LE category C.

DISCUSSION

Data from this study suggest that lifestyle patterns of activity of middle-age adults may influence the righting task of coming from a supine position to

erect stance. The more active subjects in Group 1 (daily) and Group 2 (1-2x/wk) demonstrated more developmentally advanced movement patterns, compared to the less active Group 3 (rarely) subjects. The more active groups (daily and 1-2x/wk) were categorized as using the more developmentally advanced actions on approximately 33-48% of their trials. In contrast, the least active group (rarely) performed the same actions only 17-25% of their trials.

The present investigation, along with the work of VanSant (1983,1988) and Leuhring (1988), dispell the notion of uniformity of righting behaviors for all adults. Only 25% of the adult subjects in VanSant's research and 33% of the subjects in the current investigation performed the most common form of rising. Both Schaltenbrand (1927) and McGraw (1945/1963) described movement sequences of coming from supine to standing, and suggested that developmental change was complete by early childhood. Once the adult or "mature" form of this task occurred, it presumably remained constant throughout the entire lifespan. While the task of rising emerges in the first years of life, the body actions used to perform are not universal in adulthood and may be susceptible to environmental agents, such as general activity level.

Leuhring's (1988) research with elderly adults

supports the findings of the present investigation by identifying the influential nature of activity level on the rising movement action. Leuhring evaluated the supine to standing movement pattern and concluded that active elders demonstrated more developmentally advanced movement patterns than their sedentary counterparts. Leuhring's inactive subjects most commonly performed using the UE component action category A (push & reach to bilateral push), axial component action category A (full rotation, abdomen up), and LE component action category A (half kneel). Leuhring's active subjects most commonly performed using the UE component action category B (push & reach), axial component category B (partial rotation), and LE component category A (half kneel). Thus, the active adults moved using more developmentally advanced actions in their arms and trunks. The lower extremity category was the same for the two activity level samples in Leuhring's study. In the present study , the active groups (daily and 1-2x/wk) showed more developmentally advanced lower extremity action when compared to the least active group (rarely). Subjects in the current investigation performed using the same upper extremity and axial actions, as evidenced by the two most commonly occurring actions.

VanSant's (1988) research on the pattern of rising from supine to erect stance showed young adults using primarily symmetrical component actions. The modal profile of symmetrical push of the upper extremities (C-bilateral push), symmetrical trunk action (D-symmetrical), and symmetrical lower extremity action (C-narrow base symmetrical squat) was demonstrated by VanSant's subjects (mean age 28.6 years). Symmetrical body component actions are the most advanced developmentally. In contrast, the modal profile of the subjects in the current investigation (mean age 35.5 years) involved asymmetrical component actions. They moved using an asymmetrical push of the arms (B-push and reach), with rotation of the trunk (C-forward with rotation), and an asymmetrical lower extremity action (B-asymmetrical wide-based squat). Asymmetrical body component actions are less advanced developmentally (McGraw, 1945/1963; Schaltenbrand, 1927; VanSant, 1983, 1988).

VanSant's sample was nearly seven years younger than the subjects tested in this investigation. Age difference and the tendency for the older subjects in this investigation to perform using less advanced movement patterns, suggests the possibility of developmental decline, even in these relatively young subjects. Although conclusions based on cross-sectional

comparisons are tenuous, the shift from symmetrical actions seen in the body components of the younger sample, to the asymmetrical actions noted in the older sample, might best be explained by a regression process. A developmental regression may be related to flexibility, increased body weight, decreased activity levels, or a combination of these plus other factors (Bortz, 1982; Shephard, 1987; Washburn, 1964). Physiological decline occurs with aging, but the rate of decline may be slowed by interventions such as regular exercise (Aisenbrey, 1988; Bortz, 1982; Shephard, 1987; Smith, 1982).

Age-associated physiological decrements may be prevented and even reversed with proper lifestyle habits (Aisenbrey, 1987; Bortz, 1982; Rowe & Kahn, 1987; Smith, 1982; Shephard, 1987). Exercise and weight bearing activity increase bone mineral content, to offset osteoporotic pathological changes (Aisenbrey, 1987; Shephard, 1987; Smith, 1982). Muscle mass increases correspond with increases in bone mass. Both events result from simple exercise routines. Walking (or other appropriate aerobic activities) increases cardiovascular efficiency, increases peripheral circulation, and counteracts hypertensive tendencies. Among the benefits of enhanced cardiovascular functioning are improved

oxygen exchange throughout the body, with increases in alertness and cognitive functioning (Shephard, 1987). Activity levels of the current subjects appeared to influence their movement patterns in performing the rising task. The more active subjects demonstrated more developmentally advanced movement patterns than the less active subjects. No measures of strength, flexibility, or cardiovascular fitness levels were taken on these subjects, therefore, the actual factors related to activity level influences on performance of the rising task are not clear.

VanSant (1988) did not evaluate her subjects' level of activity in her analysis of the supine to standing movement pattern. Thus, comparisons of VanSant's sample with the current sample may be confounded by the activity variable. VanSant's sample also may have included persons involved in regular activities in contrast to the present sample which involved persons of varying activity levels. Thus, the differences observed between the two samples are likely related to age and activity levels, rather than the age difference alone. Age appears to be inversely associated with activity levels such that as a person gets older, activity levels decrease (Montoye, 1975; Palmore, 1982).

In reporting lifetime involvement in vigorous physical activity, most subjects recalled daily

participation during the first two decades of life, with a decline noted after that time (20-39 years). Among the lifestyle changes credited with heightening the negative effects of aging, decrease in activity level ranks high (Bortz, 1982; Rowe et al, 1987; Shephard, 1987). Only a few subjects reported increasing physical activity with age. It should be noted that subjects' responses on the questionnaire relied upon their interpretation of vigorous physical activities, as well as their memory for frequency of participation in these activities.

Adults in the present investigation gave self-report data on patterns of activity. Descrepancies may occur between actual involvement in vigorous physical exercise and perceived involvement, as reported by subjects.

Several subjects objected to the choices of frequency of involvement in physical activities as listed on the questionnaire. The purposeful distinction between daily involvement and only once or twice a week was used to clearly separate the groups. However, some subjects who verbalized participation three to four times a week were forced to choose between the daily and once or twice a week options.

Very small differences occurred in the movement

patterns used by more active subjects (Group 1, daily and Group 2, 1-2x/wk). Possibly, the physical qualities utilized in the rising task require only moderate activity levels to achieve more developmentally advanced movements.

Arm action appeared to be an accessory part of this task of rising, with the crucial elements of movement coming from the trunk and legs. When asymmetrical arm action occurred, the trunk exhibited some degree of rotation (asymmetrical trunk action). Comparibly, symmetrical arm action coincided with symmetrical trunk action. Although the primary muscles involved in this task are located in the axial region and lower extremities, the upper extremities do influence the movement through altering the trunk action.

The sample in this study moved primarily using component body actions in the mid-range of the developmental sequence. In other words, the most common form of rising to a standing position involved body actions that were neither most advanced nor least advanced. Halverson et al (1979) noted that movements at the extremes of the developmental sequence (most advanced or least advanced) are more stable than those in the middle levels of the sequence. Furthermore, individuals at the lower levels of development tend to show more variability in movements when compared to more

developmentally advanced individuals (Table 3). Thus, the slightly greater level of variability noted in Group 3 (rarely) could be related to the lower developmental levels of action they used to perform this task.

The structure-function relationship between maturation of the central nervous system and the appearance of new behaviors might logically explain why different body regions advance developmentally at different rates. The component approach is based on the notion of independent levels of developmental advancement in separate body regions. An individual may demonstrate differing developmental actions for separate body components. In a large cross-sectional study (n=577), Thatcher et al. (1987) noted the rates and ages of human cerebral hemisphere development from 2 months of age to early adulthood by analysis of EEG (electroencephalogram) recordings. Thatcher et al. (1987) focused on comparisons of right and left hemisphere EEG recordings which matched with corresponding behavior changes compatible with developmental stages described by Piaget. Adulthood developmental changes suggest a dynamic state of central nervous system structures which might account for some of the changes noted in adult behavior.

Oppenheim (1981) emphasized the dynamic nature of

adult development. He noted that throughout the life cycle, central nervous system cell growth, cell death, reorganization, and differentiation may occur. In contrast to previous concepts labeling adulthood as a time of "maturity" or "stability", Oppenheim (1981) supported the ongoing changes which occur in the central nervous system. Perhaps the component approach to descriptions of movement patterns supports the concept that behavior is a reflection of the status of the central nervous system. Central nervous system changes might be manifested by motor behavior changes which include different developmental levels seen in separate body regions.

Flexibility measures were not taken but could be helpful in future studies of this nature as another factor affecting movement patterns in adulthood. In addition, strength assessment might provide information about how a person moves from supine to standing.

Other important questions remain to be answered regarding the influence of activity level on the developmental process. The effect of activity level on the rate of progression in the developmental sequence offers interesting implications for interventions. Additionally, the relationship between patterns of activity and how far individuals progress in the developmental sequence is not clear.

Limitations exist in observational data as investigator and/or subject bias can occur. Observational data does not control confounding variables. Thus, associations made between the movements observed and activity level may be attributed to other factors.

Data gathered in a laboratory investigation may be contaminated. Attempts made to simulate automatic movement patterns did not ensure that occurrence. The presence of videotape equipment in a laboratory setting could easily alter subjects' typical behaviors.

Statistical, rather than just descriptive analysis, would lend greater substantiation for the observed trends in behaviors and the differences noted between various groups.

Summary

This investigation involved the filming of 72 adults, 30-39 years of age, as they moved from a supine position on the floor to an erect stance. Videocameras obtained lateral and frontal views of the movement pattern. Each subject performed ten trials of the rising task. Analysis of the rising movement was modeled after the Roberton (1978) component approach in which body action is described by actions of separate

body regions. The component category checklist for rising from a supine position on the floor to an erect stance was formulated by VanSant (1983,1988). The body components for the rising movement are; 1) upper extremities, 2) axial (head-trunk) region, and 3) lower extremities.

Subjects were grouped according to self-reported participation in vigorous physical activity from responses to an activity level questionnaire. Three activity level groups resulted: Group 1 (daily participation), Group 2 (participation at least once or twice a week), and Group 3 (rarely participate in physical activity).

Comparisons of the body actions used in performing the rising task by the three activity level groups showed the more active groups (daily and 1-2x/wk) used more developmentally advanced movement patterns than the least active group (rarely).

The component approach is a useful tool for describing fundamental righting behaviors of interest to physical therapists. Adults performing the movement pattern of supine to standing demonstrated differing developmental body component actions. Also, variation between individuals existed in the patterns of movement used for the rising task.

Research in adult development reveals the dynamic

nature of adulthood behavior. Movement patterns which were once thought to be universal in adulthood are affected and influenced by lifestyle patterns. Participation in regular physical activity influences the pattern used in this righting task. More active adults demonstrated more developmentally advanced movement patterns than their less active counterparts.

Chapter 5

SUMMARY & CONCLUSIONS

Seventy-two adults, 30-39 years of age, performed ten trials of the movement pattern, supine to standing. Movements were categorized using the Roberton (1978) component approach and the component category checklist formulated by VanSant (1988). Developmental sequences for each body component, designed by VanSant (1983,1988), enabled the investigator to identify the least mature to the most mature body actions for the rising movement. Subjects showed different developmental levels and a variety of combinations of body actions used to rise from individual to individual. However, individual performance of this task confirmed consistency of movement patterns incorporated in rising.

Subjects also were grouped according to self-reported participation in regular vigorous physical activity from responses to an activity level questionnaire. Three groups resulted: Group 1, daily participation, Group 2, participation at least once or twice a week, and Group 3, rarely being involved in vigorous physical activity. Frequencies of occurrence for each category of the three body components were tabulated and percentages obtained. Comparisons of the body actions used by the three groups revealed that the

more active subjects (daily and 1-2x/wk) performed the rising movement using more developmentally advanced body actions than the least active subjects (rarely).

The component approach offered a reliable and comprehensive tool for evaluation of the supine to standing movement pattern. The current investigation added validity and support for VanSant's (1988) developmental sequence for this task. Further, the component approach allowed for an accurate and detailed description of the rising movement. From this detailed description, the investigator identified differences between individuals which reinforced the notion of heterogeniety in the adult population.

Further studies should attempt to identify other variables that alter adult movement patterns. Measures of flexibility and strength might provide relationships to activity level influences on motor patterns incorporated in functional righting tasks.

Implications

Physical therapists are particularly interested in the independent physical capabilities of healthy human beings. The role of the physical therapist is to help individuals with compromised physical functioning reestablish independent mobility in daily activities.

These daily activities include common motor skills such as moving from a lying position to sitting, elevating to standing, and assuming an erect posture for walking. To teach patients how to perform these motor tasks, the therapist must know how these tasks are accomplished by "normal" humans. Also, knowledge of what factors affect these daily motor skills is needed.

The practical implications of this study for physical therapists include modification of patient evaluation and treatment approaches. By recognizing that the level of performance of a motor pattern is not constant and stable in adulthood, the physical therapist may have several options for teaching patients how to move. No longer should motor reeducation techniques be limited to applying a single specific movement pattern previously believed to be stable throughout adulthood. When working with patients who have movement disorders, it is imperative that physical therapists have a strong foundation of knowledge in normal human movement throughout the entire lifespan. The goal of physical independence for disabled persons may be achieved through increased awareness and application of the various forms of adult movement patterns.

Studies describing functional righting behaviors in the normal population should assist physical therapists in identifying age-appropriate motor behaviors for their

adult patients. Physical therapists may select from a wide range of appropriate movement pattern combinations in teaching patients how to elevate to a standing position from a supine position on the floor.

Further, preventative medicine techniques of regular exercise not only assist in improving cardiovascular fitness levels, but also appear to play a role in efficiency of movement. More developmentally advanced movement patterns offer an individual a variety of options of movements in many different situations.

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Appendix A

CONSENT FORM

Informed Consent Form

I, ____, agree to participate in a study that describes how adults stand up from the floor. I give my permission to be videotaped while getting up to a standing position from a mat on the floor. I understand that I will be asked to stand up ten times, and may rest between trials as needed. I agree to answer some questions concerning my health and activity status. I also agree to allow the investigator to measure and record such body dimensions as my height, weight, limb length, and circumference. I understand that each trial will be videotaped and that I may refuse to participate in any portion of this study and may refuse to answer any questions with no penalty to me. I also understand that I may withdraw from the experiment at any time.

All videotapes, measurements, and information obtained from the interview will be used only for research and teaching purposes, and my identity will be protected.

I agree to wear shorts and a shirt for the videotaping so that my movement can be clearly evaluated.

All procedures have been explained to me, and all questions answered to my satisfaction. If I have additional questions at a later time, I may contact Laurel Green (532-6765), Dr.Mary McElroy (532-6765), or Dr.Robert Lowman, Office of Research and Sponsored Programs, Fairchild Hall (532-6195). To my knowledge, I have no neurological problems, cardiac problems, or any other medical conditions which would prevent me from completing this study safely.

____
Signature

____
Date

____
Date of birth

Please check the appropriate statement

( ) I agree to allow my data to be used for teaching purposes

( ) I deny the use of my data for teaching purposes

Appendix B

ACTIVITY LEVEL QUESTIONNAIRE

Activity Level Questionnaire

Subject Name: date

subject #

day month year

Birthdate:

Male Female (circle one)

Please answer the questions below by placing a check in the appropriate blank.

1. How would you rate your overall health at the present time?

_____ excellent
_____ good
_____ fair
_____ poor

2. What kind of work have you done most of your life?

_____ physical labor
_____ office job
_____ housewife/househusband
_____ never employed
_____ other (state specific occupation)_______________

3. Which of the following statements best characterizes your current involvement in physical activities.

_____ I participate in vigorous exercise daily
_____ I participate in vigorous exercise once/twice a week
_____ I occassionally participate in vigorous exercise
_____ I rarely participate in vigorous exercises

Below is a list of various physical activities. Please check ones you participate in and how often you participate in them. Activities which you do only in the summer or winter, answer according to how often you do them during that season.

	almost every day (at least 5 times a week)	about once or twice a week	about once or twice a month	less than once a month	almost never
1.tennis, racquetball, etc.	( )	( )	( )	( )	( )
2.jogging	( )	( )	( )	( )	( )
3.walking	( )	( )	( )	( )	( )
4.swimming	( )	( )	( )	( )	( )
5.bicycling	( )	( )	( )	( )	( )
6.golf	( )	( )	( )	( )	( )

almost every day (at least 5 times a week)	about once or twice a week	about once or twice a month	less than once a month	almost never
7. horseback riding ( )	( )	( )	( )	( )
8. skating ( )	( )	( )	( )	( )
9. boating ( )	( )	( )	( )	( )
10. skiing ( )	( )	( )	( )	( )
11. table tennis ( )	( )	( )	( )	( )
12. basketball ( )	( )	( )	( )	( )
13. bowling ( )	( )	( )	( )	( )
14. softball ( )	( )	( )	( )	( )
15. soccer ( )	( )	( )	( )	( )
16. volleyball ( )	( )	( )	( )	( )
17. weight-training ( )	( )	( )	( )	( )
18. calisthenics ( )	( )	( )	( )	( )
19. aerobic dance ( )	( )	( )	( )	( )
20. gardening ( )	( )	( )	( )	( )

21. other________________________________

4. For each of the time periods in your life listed below, which category most accurately describes your participation in vigorous physical activities such as those given above?

	daily	once or twice a week	occasionally	rarely
0-10 years	( )	( )	( )	( )
10-20 years	( )	( )	( )	( )
20-30 years	( )	( )	( )	( )
30-40 years	( )	( )	( )	( )

Thank you for your time.

Appendix C

DIVISION OF SUBJECTS INTO GROUPS

Division of Subjects into Groups

GROUP 1 daily exercise	GROUP 2 1-2X per week	GROUP 3 rarely
subject number	subject number	subject number
1	2	34
3	4	39
6	5	44
7	10	49
8	12	50
9	13	53
11	15	57
14	16	59
18	17	60
19	20	61
21	23	62
22	24	63
25	26	64
27	28	65
30	29	66
31	32	67
36	33	68
38	35	69
42	37	70
43	40	71
45	41	72
51	46	
52	47	
55	48	
58	54	
	56	
	TOTALS	
25	26	21

Appendix D

DEVELOPMENTAL SEQUENCES FOR BODY COMPONENTS

Developmental Sequence for the Upper Extremity Component

A-PUSH AND REACH TO BILATERAL PUSH

One hand is placed on the support surface beside the pelvis. The other UE reaches across the body, and the hand is placed on the support surface. Both hands push against the support surface to an extended elbow position. The UEs are then lifted and used for balance.

A'-PUSH AND REACH TO BILATERAL PUSH FOLLOWED BY PUSHING ON LEG

One or both hands are placed on the supporting surface beside the pelvis. After an initial push one UE reaches across the body and the hand is placed on the surface. Both hands push against the surface to an extended arm position. One or both hands are placed on the knee and then the arms are lifted and used for balance.

B-PUSH AND REACH

One or both arms are used to push against the support surface. If both arms are used, there is asymmetry or asynchrony in the pushing action or a symmetrical push gives way to a single arm push pattern.

B'-PUSH AND REACH FOLLOWED BY PUSHING ON LEG

One or both arms are used to push against the support surface, or to reach forward. Pushing and reaching movements give way to a single arm push against the support surface. One or both hands are placed on the knee and then the arms are lifted and used for balance.

C-BILATERAL PUSH

Both hands are placed on the support surface, one on each side of the pelvis. Both hands push against the support surface before the point when the UEs are lifted synchronously and used to assist in balance.

D-BILATERAL REACH

The UEs reach forward, leading the trunk, and are used to assist in balance throughout the movement.

Note. From "Rising from a supine position to erect stance: Description of adult movement and a developmental hypothesis" by A.F. VanSant, 1988, _Physical Therapy_, _68_, p. 188. Adapted by permission.

Developmental Sequence for the Axial Region Component

A-FULL ROTATION, ABDOMEN UP

The head and trunk flex and rotate to the side. Rotation continues until the ventral surface of the trunk faces, but does not contact, the support surface. The pelvis is then elevated to or above the level of the shoulder girdle. The back extends from this position vertically, with or without accompanying rotation of the trunk.

B-PARTIAL ROTATION

Flexion and rotation of the head and trunk bring the body to a side-facing position with the shoulders remaining above the level of the pelvis. The trunk extends vertically, with or without accompanying rotation.

C-FORWARD WITH ROTATION

The head and trunk flex forward with or without a slight degree of rotation. Symmetrical flexion is interrupted by rotation or extension with rotation. Flexion with slight rotation is corrected by counter-rotation in the opposite direction. One or more changes in the direction of rotation occur. A front or slightly diagonal facing is achieved before the back extends to the vertical.

D-SYMMETRICAL

The head and trunk move forward symmetrically past the vertical plane; the back then extends symmetrically to the upright position.

Note. From "Rising from a supine position to erect stance: Description of adult movement and a developmental hypothesis" by A.F. VanSant, 1988, Physical Therapy, 68, p. 190. Adapted by permission.

Developmental Sequence for the Lower Extremity Component

O-KNEEL

The legs are flexed toward the trunk and rotated to one side with both knees contacting the support surface. Half-kneeling may be assumed, or a squat pattern. When the legs extend one or more balance steps may be taken.

A-HALF KNEEL

Both legs are flexed toward the trunk as one or both legs are rotated to one side. Either a kneeling or half kneeling pattern is assumed. If kneeling occurs, one leg is then flexed forward to assume half kneeling. The forward leg pushes into extension as the opposite leg moves forward and extends.

B-ASYMMETRICAL/WIDE BASE SQUAT

One or both LEs are flexed toward the trunk, assuming an asymmetrical, crossed-leg, or wide-based squat. The legs push up to an extended position. Crossing or asymmetries may be corrected during extension by stepping action.

C-NARROW BASE SYMMETRICAL SQUAT

The LEs are brought symmetrically into flexion with the heels approximating the buttocks in a narrow-based squat. Stepping action may be seen during assumption of the squat or balance steps (or hops) may follow the symmetrical rise.

N-JUMP TO SQUAT

The legs are flexed and rotated to one side. Both legs are then lifted simultaneously off the support surface and derotated. The feet land back on the surface with hips and knees flexing to a squat or semi-squat position. The legs then extend to the vertical.

Note. From "Rising from a supine position to erect stance: Description of adult movement and a developmental hypothesis" by A.F. VanSant, 1988, Physical Therapy, 68, p.189. Adapted by permission.

Appendix E

ANTHROPOMETRIC MEASUREMENT SHEET

Subject Number:____________________

Sex: M________ F________

Date:______________________________

Anthropometric Measurements

Weight
Standing Height
Biacromial Width
Arm Length
Bicristal Width
Leg Length
Sitting Height
Head Circumference
Chest Circumference
Thigh Circumference
Hip Circumference

Appendix F

COMPONENT CATEGORIZATIONS

FOR EACH TRIAL

Appendix F

Component categorizations for each trial

subject number	Trials 1 UAL	2 UAL	3 UAL	4 UAL	5 UAL	6 UAL	7 UAL	8 UAL	9 UAL	10 UAL	modal profile UAL
1	bcb	bdb	bcb	bcb	bcb	bcb	bcb	bcc	bcc	bcb	bcb
2	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	bcb	cdc
3	abb	acb	acb	bcb	bcb	acb	bcb	bcb	bcb	bcc	bcb
4	aca	aca	aca	aca	aca	aca	aca	aca	aca	aca	aca
5	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
6	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
7	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
8	bbb	bcb	bcb	bbb	bbb	bbb	bbb	bbb	bbb	bbb	bbb
9	bcc	bcb	bcb	bcb	bdc	bcc	bcb	bdc	bdc	cdc	bcc
10	acb	acb	acb	acb	acb	acb	acb	acb	acb	acb	acb
11	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
12	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
13	bba	bba	bba	bbb	bbb	bbb	bbb	bbb	bbb	bbb	bbb
14	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
15	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
16	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
17	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
18	bcb	acb	bcb	bcb	bcb	bcb	abb	abb	ccb	abb	bcb
19	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
20	bcb	bcb	bcc	bcc	bcc	bcc	bcc	bcc	cdb	cdb	bcc
21	bcb	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
22	bbn	abn	aan	aan	aan	aan	aan	aan	aan	aan	aan
23	bcc	bcc	bcc	bcc	bcb	cdc	bcc	bcc	bcc	bcc	bcc
24	cdc	cdc	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
25	bcb	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
26	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
27	bbb	aab	aan	aan	aan	aan	aan	aan	aan	aan	aan
28	cdc	bdb	bdc	bdc	bdc	bdc	bdc	bdc	bdc	bdc	bdc
29	bcb	acb	acb	acb	acb	acb	acb	acb	acb	bcb	acb
30	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
31	bdb	cdc	bdc	bdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
32	cdb	cdb	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
33	cdc	cdc	cdc	cdc	cdb	cdc	cdb	cdc	bdb	cdb	cdc
34	cdc	cdc	cdc	bcc	bcc	bcc	bcc	bcc	bcc	bcc	bcc
35	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
36	bcb	bcb	bca	bca	bca	bca	b'ca	b'ca	b'ca	b'ca	bca
37	acc	bcb	bcb	bab	acc	bcb	bcb	bcb	bcb	bcb	bcb
38	bcb	bcc	bcb	bcb	bcb	bcb	bcb	ccb	bcb	bcb	bcb
39	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	ccb	bcb	bcb
40	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
41	cdc	cdc	cdb	cdb	bcb	cdb	cdb	cdb	cdb	cdb	cdb
42	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb

Appendix F -con't.
Component categories for each trial

subject number	1 UAL	2 UAL	3 UAL	4 UAL	5 UAL	6 UAL	7 UAL	8 UAL	9 UAL	10 UAL	modal profile UAL
43	bdc	bdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
44	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
45	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
46	bcb	bcb	bcb	bcb	cdb	cdb	bcb	cdb	bcb	bcb	bcb
47	cdc	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
48	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
49	bba	bba	b'ba	b'ba	b'ba	b'ba	b'ca	b'ca	b'ca	b'ca	b'ba
50	bcb	bcb	bcb	bcb	bcb	bcb	bcc	bcc	bcb	bcb	bcb
51	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
52	bcc	bcc	bcc	bcb	bcb	bcb	bcc	bcb	bcc	bcb	bcc
53	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
54	bcb	bcb	bcb	bcb	bcb	ccb	bcb	bcb	bcb	bcb	bcb
55	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
56	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
57	cdb	bcb	bcb	bcb	bcb	cdb	cdb	cdb	cdb	cdb	cdb
58	bdb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
59	bbb	aan	aan	aan	aab	aan	aan	bcn	aan	aan	aan
60	bcb	bcb	bcb	bcb	cdc	cdc	cdb	cdb	cdb	cdb	cdb
61	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc	cdc
62	bca	bca	bca	bca	bca	b'bo	b'co	b'co	b'bo	b'bo	bca
63	bcb	bbb	bbb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
64	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
65	cdc	cdc	cdc	ddb	cdb	cdb	cdb	cdb	cdb	cdb	cdb
66	bbb	bbb	bbb	bbb	bbb	bbb	bbb	bbb	bbb	bbb	bbb
67	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
68	bca	bca	bba	bca	bbb	bca	bba	bcb	aba	aba	bba
69	abb	aab	aab	aan	aan	aab	aab	aab	aab	aab	aab
70	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb	bcb
71	cdb	cdb	cdb	bcb	cdb	bcb	ccb	cdb	cdb	cdb	cdb
72	aaa	aaa	aaa	abo	b'bo	a'bo	a'bo	b'bo	b'bo	b'bo	abo

<u>U=</u> <u>upper</u> <u>extremity</u> <u>categories</u>
- a-push & reach to bilateral push
- a'-push & reach to bilateral push followed by pushing on leg
- b-push & reach
- b'-push & reach followed by pushing on leg
- c-bilateral push
- d-bilateral reach

<u>A=axial</u> <u>categories</u>
- a-full rotation, abdomen up
- b-partial rotation
- c-forward with rotation
- d-symmetrical

<u>L=</u> <u>lower</u> <u>extremities</u>
- o-kneel
- a-half kneel
- b-asymmetrical/wide base squat
- c-narrow base symmetrical squat
- n-jump to squat

THE RELATIONSHIP BETWEEN ACTIVITY LEVEL AND THE MOVEMENT PATTERN OF SUPINE TO STANDING

by

Laurel Nevins Green

B.S., Kansas State University, 1978

B.S., University of Kansas Medical Center, 1978

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

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1989

The purpose of the study was to describe the movement patterns of adults, 30-39 years, using the component approach, and to determine if physical activity level is related to one's ability to rise from a supine position to erect stance. Seventy-two adults performed ten trials of the movement pattern supine to standing while being filmed. Videocameras obtained lateral and frontal views of the movement pattern. Subjects, supine on an exercise mat, were instructed to stand up as quickly as possible. Between trial intervals were self paced by the subjects. Movements were categorized using the Roberton (1978) component approach which consists of describing movement patterns in separate body regions. The component category checklist for this righting task was formulated by VanSant (1988) and includes three body components: 1)upper extremities, 2)axial (head-trunk) region, and 3)lower extremities. Subjects were grouped according to participation in regular vigorous physical activity from responses to an activity level questionnaire. The questionnaire, in multiple choice format, allowed subjects to identify a wide range of possible physical activities in addition to an opportunity to list any activity which was absent from the questionnaire. Group 1 consisted of 25 subjects who reported daily

participation in vigorous physical activity. Group 2 consisted of 26 subjects who reported participation in vigorous physical activity once or twice a week. Group 3 consisted of 21 subjects who reported rarely participating in vigorous physical activity. Comparisons between the three activity level groups revealed that the more active Group 1 (daily) and Group 2 (1-2x/wk) demonstrated more developmentally advanced movement patterns for the righting task of coming from a supine position to erect stance than Group 3 (rarely). Modal profiles for the component categories resulted from the most frequently performed body component action. Modal profiles of the upper extremity component showed 41% of Group 1 and Group 2 in the more developmentally advanced upper extremity movement patterns with only 28% of Group 3 in this category. Modal profiles of the axial component showed 42% of Group 1 and Group 2 in the most developmentally advanced axial movement pattern with only 28% of Group 3 demonstrating this pattern. Modal profiles of the lower extremity component showed 37% of Group 1 and Group 2 in the most developmentally advanced lower extremity movement pattern with only 14% of Group 3 demonstrating this pattern. Anthropometric measurements and body girth measurements were taken on all subjects but were not used for the current investigation.